

Fourth Harmonic Analyzer

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The X-band downlink receiver frequency is situated very close to the fourth harmonic of the S-band high-power transmitter. When wideband modulation is applied to the high-power transmitter, the sidebands of the fourth harmonic are of such magnitude to the X-band receiver that they interfere with X-band downlink or will saturate the X-band maser. To alleviate this problem, a fourth harmonic filter was added to the output of the high-power transmitter. No quantitative results of this experiment were obtained. To make an analytic measurement, a fourth harmonic analyzer has been developed to measure the power at the fourth harmonic of the S-band high-power transmitter with and without a fourth harmonic filter.

I. Introduction

With the development of an X-band downlink from spacecraft to be used simultaneously with an S-band uplink, a more sophisticated and sensitive X-band receiving system has been developed and installed at DSS 14. With the use of the X-band downlink receivers a problem was discovered. This problem was that the fourth harmonic of the high-power transmitter (S-band uplink) was of sufficient magnitude that its sidebands were stronger than the X-band downlink signal expected from a spacecraft. To alleviate this problem an X-band filter was added to the feed system of the high-power transmitter. To determine if this was an effective solution to the problem, a source for measuring the fourth harmonic magnitude is required. An analyzer has been developed (Fig. 1) to measure the magnitude of the fourth harmonic in the S-band waveguide (WR-430) in any mode or combination of modes and to develop operational techniques in measuring harmonics.

II. Description

The fourth harmonic analyzer is basically a harmonic filter of a leaky-wall type (Fig. 2), utilizing secondary waveguides which are beyond cutoff of the fundamental, second and third harmonics of the S-band high-power transmitter. The secondary waveguides are mounted on one broad wall and both of the narrow walls of the primary waveguide. There are 60 secondary waveguides mounted on each of the narrow walls and 120 on the broad wall (Fig. 3). The large number of secondary waveguide couplings are necessary because of the many modes that can exist in a fourth harmonic. There can be in excess of 29 different modes at the fourth harmonic. There are slits cut in the wall of the primary waveguide (WR-430) to allow coupling to the secondary waveguides (WR-90). The secondary waveguide has a movable load mounted within the waveguide. As the load is removed, a coupling loop is exposed so that the power within the secondary waveguide can be measured using a power meter. Because

of the spacing of the secondary waveguide on the walls, a special probe was developed to slide into each of the secondary waveguides so that the power meter could be coupled to the secondary waveguide. The removable load has an "O" ring gasket to maintain the pressure integrity of the waveguide system.

III. Performance

The absorption loss of the primary waveguide at the fourth harmonic was supposed to be at least 6 dB. After the unit was made and measurements taken, it was determined that the absorption loss is as low as 4.8 dB. The design goal of 6 dB would cause a maximum measurement uncertainty of 1.25 dB. The actual insertion loss causes a maximum measurement uncertainty of 1.75 dB. The difference between the calculated and the actual insertion measurement results is due to poor mismatch of the secondary waveguides. The VSWR of each of the secondary

waveguides was measured. A correction factor for each secondary waveguide power measurement will correct the reading and improve the accuracy of the fourth harmonic measurement.

Presently the fourth harmonic analyzer is being used in the laboratory to develop more exact measurement techniques. A computer program is being developed to take the raw data and to format them into usable results. It is hoped that the use of the learning method in the laboratory and the computer program will result in a lower measurement error.

IV. Future Plans

In the near future the analyzer will be inserted into the high-power microwave system at DSS 13, and actual high power measurements will be made.

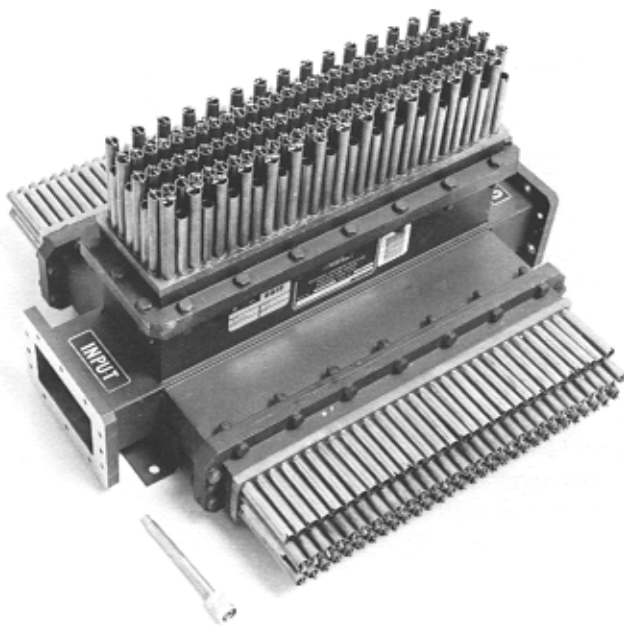


Fig. 1. Fourth harmonic analyzer with RF probe

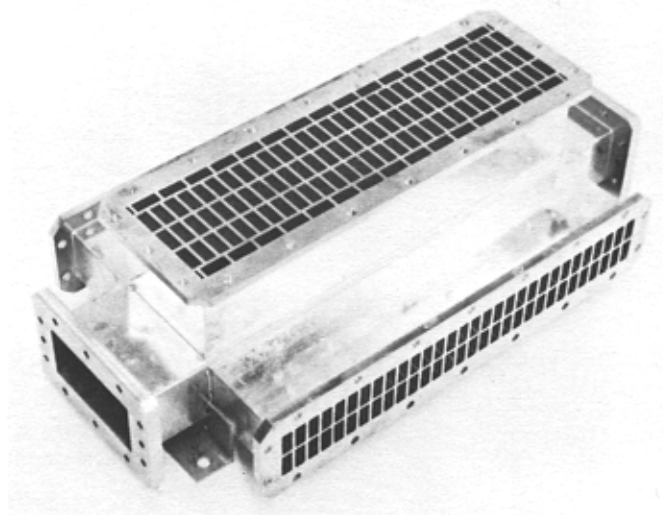


Fig. 2. Main waveguide (WR-430) and fourth harmonic coupled waveguide (WR-90) of the fourth harmonic analyzer

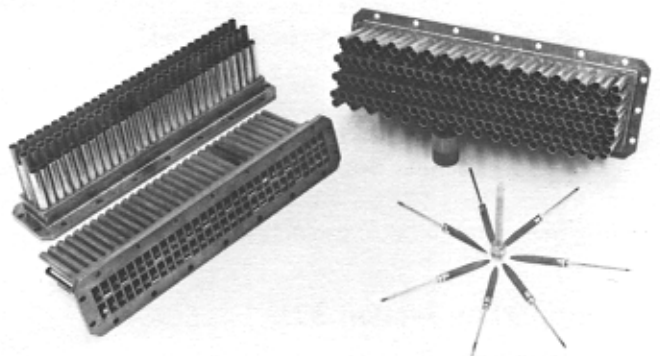


Fig. 3. Broad wall and narrow wall load and sample ports and load and sample of the fourth harmonic analyzer